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## Asthma in Health Care Workers:

### 2008 and 2010 Behavioral Risk Factor Surveillance System Asthma Call-Back Survey

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### Abstract

**Objective**—To estimate the prevalence of current asthma and the proportion of asthma that is work-related among health care and non-health care workers.

**Methods**—We used 2008 and 2010 Behavioral Risk Factor Surveillance System High Risk/Health Care Worker Module and Asthma Call-Back Survey data collected in 35 states and the District of Columbia to estimate prevalence ratios (PRs).

**Results**—Significantly more health care workers/volunteers than non-health care workers/volunteers with current asthma had asthma attacks (PR = 1.23; 95% confidence interval = 1.03 to 1.46) and asthma symptoms within the past year (PR = 1.07; 95% confidence interval = 1.00 to 1.14). There was no significant difference in the proportion of health care and non-health care workers/volunteers diagnosed with current asthma or work-related asthma.

**Conclusions**—The results of this study are consistent with previous research showing that health care workers with asthma have higher proportions of asthma attacks than non-health care workers.

Asthma is a chronic disorder of the airways characterized by symptoms of wheezing, coughing, chest tightness, and shortness of breath.<sup>1</sup> In 2010, an estimated 15 million working-age (18 to 64 years old) adults in the United States had asthma.<sup>2</sup> Many exposures can cause or exacerbate asthma, including those in the workplace.<sup>1</sup> Work-related asthma is a subset of asthma that is caused by or exacerbated by work-related factors.<sup>3</sup> Among adults with current asthma, an estimated 9.0% have health professional-diagnosed work-related asthma and an additional 37.5% describe their asthma as caused or made worse by workplace exposures.<sup>4</sup>

In 2008, there were 13.3 million people employed in private-sector health care in the United States.<sup>5</sup> Population-based research has shown that among adults with lifetime asthma, health care workers have a higher prevalence of asthma attacks than non-health care workers.<sup>6</sup>

Case-based surveillance systems in four states found that among work-related asthma cases,

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health care workers were over-represented compared with the percentage expected on the basis of workforce composition.<sup>7</sup>

To date, little population-based information exists on work-related asthma in US health care workers. To estimate the prevalence of current asthma and the proportion of asthma that is work-related among health care workers, we analyzed 2008 and 2010 Behavioral Risk Factor Surveillance System (BRFSS) High Risk/Health Care Worker Module and Asthma Call-Back Survey data collected in 35 states and the District of Columbia (DC) from persons aged 18 years or more who were employed in the year before the interview.

## METHODS

### Data Source

The BRFSS is an ongoing, state-based, telephone survey of noninstitutionalized adults in the United States that collects information on health risk behaviors, health care access, and disease status.<sup>8</sup> To identify health care workers at risk for influenza, the High Risk/Health Care Worker Module was administered as part of BRFSS in select states in 2008 and 2010. The Asthma Call-Back Survey was administered within 2 weeks of the BRFSS interview to a subset of respondents who indicated that they had ever had asthma.<sup>9</sup> See the footnote in Table 1 for a list of states conducting the High Risk/Health Care Module and Asthma Call-Back Survey in 2008 and 2010. The Council of American Survey and Research Organizations median response rate among the three participating states in 2008 was 48.2% for BRFSS and 50.6% for the Asthma Call-Back Survey, and for the 35 states and the DC participating in 2010 the median response rate was 52.0% for BRFSS and 49.8% for the Asthma Call-Back Survey. The BRFSS has surveillance exemption from the Institutional Review Board at the Centers for Disease Control and Prevention. Participating states are subject to state-specific Institutional Review Board requirements.

### Study Population and Definitions

For this analysis, the study population included adults who had been employed in the year before the interview, that is, those who answered “employed for wages,” “self-employed,” or “out of work for less than 1 year” to the question “Are you currently ... employed for wages, self-employed, out of work for more than 1 year, out of work for less than 1 year, a homemaker, a student, retired, or unable to work?” Health care workers/volunteers were persons who answered “yes” to the question “Do you currently volunteer or work in a hospital, medical clinic, doctor’s office, dentist’s office, nursing home or some other health care facility? This includes part-time and unpaid work in a health care facility as well as professional nursing care provided in the home.”

Questions pertaining to asthma history, asthma-related health care utilization, and work-related asthma used in this report are shown in Table 1. We defined non-work-related asthma on the basis of a “no” response to all of the health professional-diagnosed and possible work-related asthma questions in Table 1.

## Statistical Analysis

We used SAS® software version 9.3 (SAS Institute Inc, Cary, NC) survey procedures and SUDAAN® Release 10.0.1 software (Research Triangle Institute, Research Triangle Park, NC) to account for the complex survey design. Data were weighted to account for nonresponse differences in the sample and the unequal probability of sample selection in order to produce representative estimates. For states that administered the High Risk/Health Care Module to a subset of the state sample in one version of the questionnaire, the Asthma Call-Back Survey final weight was proportionately adjusted based on the value of the BRFSS core final weight. For the three states with 2 years of data, weights based on the proportionate distribution of the sample completing the High Risk/Health Care Module and the Asthma Call-Back Survey between the 2 years were calculated.

We compared health care workers/volunteers and non-health care workers/volunteers using multivariate logistic regression. All multivariate associations were adjusted for age (continuous), sex, annual household income (three categories: <\$25,000, \$25,000 to \$49,999, and \$50,000), and health insurance status (two categories: insured and not insured) because these variables were independently associated with both employment as a health care worker/volunteer and current asthma status.

## RESULTS

### Adults Employed in the Year Before the Interview

A total of 182,825 (representing an estimated 115.6 million) adults in the 35 states and the DC that administered the BRFSS High Risk/Health Care Worker Module in 2008 and 2010 were employed in the year before the interview. Of adults employed in the year before the interview, 7.5% had current asthma and 13.3% were health care workers/volunteers (Table 2).

After adjusting for covariates, health care workers/volunteers were more likely than non-health care workers/volunteers to be female (prevalence ratio [PR] = 1.72; 95% confidence interval [CI] = 1.67 to 1.77), to be other race/ethnicity (PR = 1.06; 95% CI = 1.01 to 1.11), to have more than a high school education (PR = 1.16; 95% CI = 1.14 to 1.18), to have an annual household income greater than or equal to \$50,000 (PR = 1.09; 95% CI = 1.06 to 1.12), and to have health insurance (PR = 1.05; 95% CI = 1.03 to 1.06). In addition, health care workers/volunteers had a significantly higher prevalence of current asthma than non-health care workers/volunteers (8.8% vs 7.0%, respectively). Nevertheless, after adjusting for covariates, the association was not significant (PR = 1.06; 95% CI = 0.95 to 1.18) (Table 2).

### Adults With Current Asthma Employed in the Year Before the Interview

Most adults with current asthma employed in the year before the interview were aged 18 to 44 years (58.0%), female (59.6%), non-Hispanic white (74.6%), had more than a high school education (73.6%), had an annual household income of \$50,000 or more (58.7%), had health insurance (86.0%), and were never smokers (60.3%) (Table 3). After adjusting for covariates, health care workers/volunteers with current asthma were more likely to be 18

to 44 years old, female, and former smokers and less likely to have an annual household income of less than \$25,000 than non-health care workers/volunteers with current asthma (Table 3).

Among adults with current asthma employed in the year before the interview, higher proportions of health care workers/volunteers than non-health care workers/volunteers have had an asthma attack in the past year (adjusted PR = 1.23; 95% CI = 1.03 to 1.46), had asthma symptoms within the past year (adjusted PR = 1.07; 95% CI = 1.00 to 1.14), and been advised to change things in their home, work, or school environment (adjusted PR = 1.26; 95% CI = 1.04 to 1.52). Nevertheless, health care workers/volunteers with current asthma did not differ from non-health care workers/volunteers with current asthma in education level, health insurance status, age of asthma onset, asthma control level, the proportion of adults that had routine checkups for their asthma, urgent treatment for worsening asthma, asthma-related emergency room visits, activity limitation because of asthma, the time since they last talked to a health professional about their asthma, the time since they last took asthma medication, and work-related asthma status (Table 3).

## DISCUSSION

The results of this cross-sectional study are consistent with previous research showing that health care workers have higher prevalence of current asthma and that health care workers with current asthma have higher proportions of asthma attacks than non-health care workers.<sup>6,10</sup> We found that health care workers/volunteers had a higher prevalence of current asthma than non-health care workers/volunteers (but this difference was eliminated when adjusting for covariates), and that there was no difference in the proportion of work-related asthma between health care workers/volunteers and non-health care workers/volunteers with current asthma. This population-based study is one of the first in the United States to evaluate the proportion of asthma that is diagnosed as work-related among health care workers.

Our findings are consistent with the research by Arif and colleagues<sup>11,12</sup> that have found the health care industry and health-related occupations are not at an increased risk for work-related asthma. In their study, the authors examined work-related asthma through symptoms such as wheezing, whistling, stuffy, itchy, or runny nose among adults with asthma in different industries and found that health care workers did not have an elevated risk for work-related asthma.<sup>11</sup> Previous population-based research also found that health-related occupations did not have higher prevalence of work-related asthma than referent groups of management, secretarial, and clerical-related occupations.<sup>12</sup> Nevertheless, this past research used National Health and Nutrition Examination Survey data that did not have a direct question assessing whether the respondent had health professional-diagnosed work-related asthma but rather relied on a question assessing whether a respondent with asthma had symptoms brought on by the work environment.<sup>11,12</sup> In addition, the previous studies categorized industry and occupation on the basis of the respondent's longest-held job, although we used the respondent's current job or volunteer activity.<sup>11,12</sup>

Nonetheless, many studies have found that health care workers are at an increased risk for both asthma and work-related asthma.<sup>7,10,13–15</sup> In a study of the employed population in Finland, Karjalainen and colleagues<sup>13</sup> estimated the incidence of asthma to be significantly higher in medical and nursing work than in administrative work (relative risk = 1.1 to 1.2). Using data from the European Community Respiratory Health Survey, they found that nurses were at an increased risk for new-onset asthma compared with professional, clerical, and administrative occupations (odds ratio = 2.22; 95% CI = 1.25 to 3.96).<sup>14</sup> In addition, a population-based study in the United States found that the prevalence of asthma was higher in white females employed in the health care industry than in industries with office employment.<sup>10</sup>

In four state-based sentinel work-related asthma surveillance systems, health care workers were overrepresented (16%) compared with health care workers as a percentage of the total workforce (8%).<sup>7</sup> Health care workers were also more likely to have work-aggravated asthma than non-health care workers (23% vs 18%).<sup>7</sup> These findings may be due to differential diagnosis, reporting, and case confirmation in health care workers.<sup>7</sup> In a Canadian study of workers' compensation claims for work-exacerbated and occupational asthma, the most frequent industry for work-exacerbated asthma was the health care industry, and the rate of allowed claims for work-exacerbated asthma was significantly greater in health care than in other industries.<sup>15</sup>

The roles of health care workers and the specific occupational tasks they perform vary widely.<sup>16</sup> Certain exposures may be widespread in the health care industry including cleaning products, latex, glutaraldehyde, and formaldehyde.<sup>7,14,17–20</sup> Mirabelli and colleagues<sup>16</sup> found that nursing and health care workers did not have an elevated risk for developing new-onset asthma compared with other workers. Nevertheless, the authors did find an elevated risk of asthma among nursing and health care workers who reported certain occupational exposures such as using ammonia or bleach cleaning products more than once per week and among particular occupational groups such as hospital technicians and personal care providers in institutional environments.<sup>16</sup> The BRFSS was not designed to collect information on specific occupational subgroups and exposures.

The results of this study suggest that the age of health care workers/volunteers and non-health care workers/volunteers does not differ. Nevertheless, among those with current asthma, health care workers/volunteers are more likely to be 18 to 44 years old than non-health care workers/volunteers. The reasons for the difference are not apparent. One possibility is the “healthy worker survivor effect” where workers self-select themselves out of jobs with high exposures—a phenomenon that may be more likely to occur with longer duration of employment.<sup>21,22</sup>

This study is subject to some limitations. Because of the cross-sectional survey design, we were not able to assess whether the respondents' asthma and work-related asthma were caused or made worse by workplace exposures specific to the health care or any other industry. The survey was not designed to collect detailed information on job history or exposure. In addition, it was not possible to analyze the data separately for workers and volunteers. Nevertheless, in 2013, the Centers for Disease Control and Prevention will

sponsor a BRFSS optional module designed to collect respondents' current employment information such as industry and occupation. This information, when available, may allow for further detailed analysis of asthma and work-related asthma among workers in the health care industry. Finally, the results of this study are not representative of nonparticipating states or the entire US population.

To our knowledge, this population-based study is the first to evaluate the proportion of asthma that is diagnosed as work-related among health care workers in the United States. These results suggest that health care workers/volunteers with asthma have higher prevalence of asthma attacks than non-health care workers/volunteers. Future studies should examine factors associated with work-related asthma in health care workers.

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## References

1. National Asthma Education and Prevention Program. Expert Panel Report 3 (EPR-3): Guidelines for the diagnosis and management of asthma—summary report 2007. *J Allergy Clin Immunol.* 2007; 120:S94–138. [PubMed: 17983880]
2. Moorman JE, Akinbami LJ, Bailey CM, et al. National Surveillance of Asthma: United States, 2001–2010. National Center for Health Statistics. *Vital Health Stat.* 2012;3.
3. Tarlo S, Balmes J, Balkissoon R, et al. Diagnosis and management of work-related asthma: American College of Chest Physicians Consensus Statement. *Chest.* 2008; 134:1S–41S. [PubMed: 18779187]
4. Knoeller GE, Mazurek JM, Moorman JE. Health-related quality of life among adults with work-related asthma in the United States. *Qual Life Res.* 2012;1007/s11136-012-0206-7
5. Bureau of Labor Statistics, United States Department of Labor. [Accessed November 28, 2012] Health Care—Spotlight on Statistics: Chart Data. Rising Health Care Employment. Available at <http://www.bls.gov/spotlight/2009/healthcare/data.htm#chartces>. Published 2009
6. Syamlal G, Mazurek JM, Bang KM. Prevalence of lifetime asthma and current asthma attacks in U.S. working adults: an analysis of the 1997–2004 National Health Interview Survey data. *J Occup Environ Med.* 2009; 51:1066–1074. [PubMed: 19730397]
7. Pechter E, Davis LK, Tumpowsky C, et al. Work-related asthma among health-care workers: surveillance data from California, Massachusetts, Michigan, and New Jersey, 1993–1997. *Am J Ind Med.* 2005; 47:265–275. [PubMed: 15712261]
8. Centers for Disease Control and Prevention. [Accessed November 13, 2012] Behavioral Risk Factor Surveillance System. Available at <http://www.cdc.gov/brfss/>. Published 2010
9. Centers for Disease Control and Prevention. [Accessed November 13, 2012] BRFSS asthma call-back survey. Available at <http://www.cdc.gov/brfss/acbs/index.htm>. Published 2012
10. Bang K, Hnizdo E, Doney B. Prevalence of asthma by industry in the US population: a study of 2001 NHIS data. *Am J Ind Med.* 2005; 47:500–508. [PubMed: 15898089]
11. Arif AA, Whitehead LW, Delclos GL, et al. Prevalence and risk factors of work related asthma by industry among United States workers: data from the third National Health and Nutrition Examination Survey (1988–94). *Occup Environ Med.* 2002; 59:505–511. [PubMed: 12151605]
12. Arif AA, Delclos GL, Whitehead LW, Tortolero SR, Lee ES. Occupational exposures associated with work-related asthma and work-related wheezing among U.S. workers. *Am J Ind Med.* 2003; 44:368–376. [PubMed: 14502764]

13. Karjalainen A, Kurppa K, Martikainen R, et al. Work is related to a substantial portion of adult-onset asthma incidence in the Finnish population. *Am J Resp Crit Care Med*. 2001; 164:565–568. [PubMed: 11520716]
14. Kogevinas M, Zock J-P, Jarvis D, et al. Exposure to substances in the work-place and new-onset asthma: an international prospective population-based study (ECRHS-II). *Lancet*. 2007; 370:336–341. [PubMed: 17662882]
15. Liss GM, Buyantseva L, Luce CE, et al. Work-related asthma in health care in Ontario. *Am J Ind Med*. 2011; 54:278–284. [PubMed: 21328417]
16. Mirabelli MC, Zock JP, Plana E, et al. Occupational risk factors for asthma among nurses and related healthcare professionals in an international study. *Occup Environ Med*. 2007; 64:474–479. [PubMed: 17332135]
17. Bousquet J, Flahault A, Vandenplas O, et al. Natural rubber latex allergy among health-care workers: a systematic review of the evidence. *J Allergy Clin Immunol*. 2006; 118:447–454. [PubMed: 16890771]
18. Delclos G, Gimeno D, Arif A, et al. Occupational risk factors and asthma among health care professionals. *Am J Resp Crit Care Med*. 2007; 175:667–675. [PubMed: 17185646]
19. Arif AA, Delclos GL. Association between cleaning-related chemicals and work-related asthma and asthma symptoms among healthcare professionals. *Occup Environ Med*. 2012; 69:35–40. [PubMed: 21602538]
20. Arif AA, Delclos GL, Serra C. Occupational exposures and asthma among nursing professionals. *Occup Environ Med*. 2009; 66:274–278. [PubMed: 19164328]
21. LeMoual N, Kauffmann F, Eisen E, Kennedy S. The healthy worker effect in asthma: work may cause asthma, but asthma may also influence work. *Am J Resp Crit Care Med*. 2008; 177:4–10. [PubMed: 17872490]
22. Zock JP, Heederik D, Doekes G. Evaluation of chronic respiratory effects in the potato processing industry: indications of a healthy worker effect? *Occup Environ Med*. 1998; 55:823–827. [PubMed: 9924443]



TABLE 1

2008 and 2010 Asthma Call-Back Survey Questions Used in This Report\*

Definition	Asthma Call-Back Survey Question
Lifetime asthma	Have you ever been told by a doctor, nurse, or other health professional that you had asthma? <sup>†</sup>
Current asthma	Do you still have asthma? <sup>†</sup>
Age of asthma onset	How old were you when you were first told by a doctor or other health professional that you had asthma? <sup>‡</sup>
Asthma attack	During the past 12 mo, have you had an episode of asthma or asthma attack? <sup>†</sup>
Activity limitation because of asthma	During the past 12 mo, how many days were you unable to work or carry out your usual activities because of your asthma? <sup>§</sup>
Time since last talked to the health professional about asthma	How long has it been since you last talked to a doctor or other health professional about your asthma? <sup>//</sup>
Time since last took asthma medication	How long has it been since you last took asthma medication? <sup>¶</sup>
Time since last had asthma symptoms	How long has it been since you last had any symptoms of asthma? <sup>¶</sup>
Routine checkup for asthma	During the past 12 mo, how many times did you see a doctor or other health professional for a routine checkup for your asthma? <sup>#</sup>
Urgent treatment for worsening asthma	During the past 12 mo, how many times did you see a doctor or other health professional for urgent treatment of worsening asthma symptoms or for an asthma episode or attack? <sup>#</sup>
Asthma-related emergency room visit	During the past 12 mo, have you had to visit an emergency room or urgent care center because of your asthma? <sup>†</sup>
Asthma-related hospitalization	During the past 12 mo, have you had to stay overnight in a hospital because of your asthma? <sup>†</sup>
Health professional-diagnosed work-related asthma	Were you ever told by a doctor or other health professional that your asthma was related to any job you ever had? <sup>†</sup>
Possible work-related asthma **	Was your asthma caused by chemicals, smoke, fumes, or dust in your current job? <sup>†</sup> Was your asthma caused by chemicals, smoke, fumes, or dust in any previous job you ever had? <sup>†</sup> Is your asthma made worse by chemicals, smoke, fumes, or dust in your current job? <sup>†</sup> Was your asthma made worse by chemicals, smoke, fumes, or dust in any previous job you ever had? <sup>†</sup>
Change or quit job because of asthma	Did you ever change or quit a job because chemicals, smoke, fumes, or dust caused your asthma or made your asthma worse? <sup>†</sup>

\* In 2008, three states (Florida, Hawaii, and New York) and in 2010, 35 states (Alabama, Arizona, California, Connecticut, Florida, Georgia, Hawaii, Illinois, Indiana, Iowa, Kansas, Louisiana, Maine, Maryland, Massachusetts, Michigan, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, Texas, Utah, Washington, West Virginia, and Wisconsin) and the District of Columbia conducted the High Risk/Health Care Module and the Asthma Call-Back Survey.

<sup>†</sup> Response options include “yes” or “no.”

<sup>‡</sup> Response options include numeric age in years.

<sup>§</sup> Response options include the numeric number of days.

<sup>//</sup> Response options include “within the past year,” “1 year to less than 3 years ago,” “3 to 5 years ago,” and “more than 5 years ago.”

<sup>¶</sup> Response options include “less than 1 day ago,” “1 to 6 days ago,” “1 week to less than 3 months ago,” “3 months to less than 1 year ago,” “1 year to less than 3 years ago,” “3 years to 5 years ago,” and “more than 5 years ago.”

<sup>#</sup> Response options include the numeric number of times.

\*\* Among respondents who did not have health professional-diagnosed work-related asthma (ie, responded “no” or “do not know”).



TABLE 2

Characteristics of Adults Employed in the Year Before the Interview

Characteristics	Total			Health Care Workers/ Volunteers (N = 15,285) % <sup>‡</sup> (95% CI)	Non-Health Care Workers/Volunteers (N = 84,673) % <sup>‡</sup> (95% CI)	Unadjusted PR (95% CI)	Adjusted PR <sup>§</sup> (95% CI)
	N*	Weighted N (in Thousands) <sup>†</sup>	% <sup>‡</sup> (95% CI)				
Age, yr							
18–44	63,594	65,180	56.7 (56.3–57.1)	54.8 (53.4–56.2)	57.6 (57.0–58.2)	0.95 (0.93–0.98)	1.00 (0.97–1.03)
45	117,461	49,746	43.3 (42.9–43.7)	45.2 (43.8–46.6)	42.4 (41.8–43.0)	1.07 (1.03–1.10)	1.01 (0.97–1.05)
Sex							
Male	78,213	63,390	54.8 (54.4–55.3)	30.0 (28.5–31.5)	59.0 (58.3–59.6)	0.51 (0.48–0.54)	0.51 (0.49–0.54)
Female	104,612	52,210	45.2 (44.7–45.6)	70.0 (68.5–71.5)	41.0 (40.4–41.7)	1.71 (1.66–1.75)	1.72 (1.67–1.77)
Race/ethnicity							
White, non-Hispanic	140,378	77,067	67.4 (66.9–67.9)	66.1 (64.6–67.6)	65.1 (64.4–65.8)	1.02 (0.99–1.04)	0.97 (0.94–0.99)
Other	40,305	37,268	32.6 (32.1–33.1)	33.9 (32.4–35.4)	34.9 (34.2–35.6)	0.97 (0.92–1.02)	1.06 (1.01–1.11)
Education level							
High school or less	55,393	36,566	31.7 (31.2–32.1)	18.9 (17.8–20.1)	34.1 (33.5–34.8)	0.56 (0.52–0.59)	0.67 (0.63–0.71)
More than high school	127,140	78,871	68.3 (67.9–68.8)	81.1 (79.9–82.2)	65.9 (65.2–66.5)	1.23 (1.21–1.25)	1.16 (1.14–1.18)
Annual household income, \$							
<25,000	27,677	18,711	17.8 (17.4–18.2)	14.0 (12.9–15.2)	19.2 (18.6–19.8)	0.73 (0.67–0.80)	0.83 (0.77–0.89)
25,000–49,999	42,445	23,586	22.4 (22.0–22.8)	21.1 (19.9–22.3)	22.7 (22.1–23.3)	0.93 (0.87–0.99)	0.92 (0.86–0.98)
50,000	96,128	63,002	59.8 (59.4–60.3)	64.9 (63.4–66.4)	58.1 (57.4–58.8)	1.12 (1.09–1.15)	1.09 (1.06–1.12)
Health insurance							
Yes	160,053	97,437	84.5 (84.1–84.9)	90.4 (89.5–91.3)	83.2 (82.6–83.8)	1.09 (1.07–1.10)	1.05 (1.03–1.06)
No	22,437	17,849	15.5 (15.1–15.9)	9.6 (8.7–10.5)	16.8 (16.2–17.4)	0.57 (0.52–0.63)	0.76 (0.70–0.84)
Smoking status							
Current	29,754	19,378	16.9 (16.6–17.3)	13.1 (12.2–14.1)	17.1 (16.6–17.7)	0.77 (0.71–0.83)	0.90 (0.83–0.97)
Former	47,481	25,278	22.1 (21.7–22.4)	20.9 (19.7–22.1)	22.2 (21.7–22.8)	0.94 (0.88–1.00)	1.00 (0.94–1.06)
Never	104,553	69,806	61.0 (60.6–61.4)	66.0 (64.6–67.4)	60.6 (60.0–61.3)	1.09 (1.06–1.12)	1.03 (1.00–1.06)
Lifetime asthma							
Yes	22,711	14,345	12.4 (12.1–12.7)	13.3 (12.3–14.3)	12.1 (11.7–12.5)	1.10 (1.01–1.19)	1.00 (0.91–1.09)
No	159,714	101,039	87.6 (87.3–87.9)	86.7 (85.7–87.7)	87.9 (87.5–88.3)	0.99 (0.97–1.00)	1.00 (0.99–1.01)
Current asthma							

Characteristics	Total		Health Care Workers/ Volunteers (N = 15,285) % <sup>‡</sup> (95% CI)	Non-Health Care Workers/ Volunteers (N = 84,673) % <sup>‡</sup> (95% CI)	Unadjusted PR (95% CI)	Adjusted PR <sup>§</sup> (95% CI)
	N*	Weighted N (in Thousands) <sup>‡</sup>				
Yes	14,367	8,595	7.5 (7.2–7.7)	8.8 (8.0–9.6)	1.26 (1.14–1.40)	1.06 (0.95–1.18)
No	167,449	106,429	92.5 (92.3–92.8)	91.2 (90.4–92.0)	0.98 (0.97–0.99)	1.00 (0.99–1.00)
Total	182,825	115,600		13.3 (12.9–13.7)		

\* Unweighted sample size. The numbers for characteristic subgroups may not add to total because of missing values. The sample size for health care workers/volunteers and non-health care workers/volunteers does not sum to total because only a subset of respondents completed both the High Risk/Health Care Worker Module and Asthma Call-Back Survey.

<sup>‡</sup> Weighted to the state population using the survey sample weights for each BRFSS participant.

<sup>§</sup> Results presented as weighted average annual estimate.

<sup>§</sup> Prevalence ratio, adjusted for age, sex, annual household income, and health insurance status.

BRFSS, Behavioral Risk Factor Surveillance System; CI, confidence interval; PR, prevalence ratio.

Characteristics of Adults With Current Asthma Employed in the Year Before the Interview

TABLE 3

Characteristics	Total		Health Care Workers/ Volunteers (N = 570) % <sup>‡</sup> (95% CI)	Non-Health Care Workers/Volunteers (N = 2437) % <sup>‡</sup> (95% CI)	Unadjusted PR (95% CI)	Adjusted PR <sup>§</sup> (95% CI)
	N*	Weighted N (in Thousands) <sup>†</sup>				
Age, yr						
18–44	1,613	5,899	66.6 (58.8–74.5)	56.6 (52.6–60.6)	1.18 (1.02–1.36)	1.19 (1.03–1.38)
45	3,494	4,279	33.4 (25.5–41.2)	43.4 (39.4–47.4)	0.77 (0.59–1.00)	0.76 (0.58–0.99)
Sex						
Male	1,507	4,114	40.4 (37.3–43.4)	42.9 (38.6–47.3)	0.40 (0.26–0.61)	0.34 (0.22–0.51)
Female	3,621	6,082	59.6 (56.6–62.7)	57.1 (52.7–61.4)	1.45 (1.29–1.63)	1.54 (1.38–1.72)
Race/ethnicity						
White, non-Hispanic	4,087	7,552	74.6 (71.9–77.4)	74.0 (70.0–78.0)	0.60 (0.37–0.96)	1.00 (0.88–1.14)
Other	1,009	2,565	25.4 (22.6–28.1)	26.0 (22.0–30.0)	1.16 (1.04–1.29)	1.00 (0.69–1.44)
Education level						
High school or less	1,267	2,690	26.4 (23.7–29.1)	28.2 (24.2–32.2)	1.04 (0.92–1.17)	0.81 (0.55–1.20)
More than high school	3,855	7,496	73.6 (70.9–76.3)	71.8 (67.8–75.8)	0.89 (0.61–1.30)	1.07 (0.96–1.19)
Annual household income, \$						
<25,000	850	1,505	16.1 (13.9–18.3)	18.2 (14.7–21.8)	0.46 (0.29–0.73)	0.52 (0.34–0.80)
25,000–49,999	1,249	2,350	25.1 (22.5–27.8)	26.0 (22.0–29.9)	1.07 (0.75–1.54)	1.13 (0.79–1.62)
50,000	2,660	5,490	58.7 (55.7–61.8)	55.8 (51.4–60.3)	1.14 (0.97–1.35)	1.09 (0.92–1.29)
Health insurance						
Yes	4,584	8,751	86.0 (83.7–88.3)	93.5 (90.6–96.5)	1.10 (1.05–1.17)	1.04 (0.98–1.10)
No	538	1,426	14.0 (11.7–16.3)	6.5 (3.5–9.4)	0.43 (0.25–0.72)	0.75 (0.47–1.21)
Smoking status						
Current	738	1,628	16.0 (13.7–18.3)	16.2 (12.9–19.6)	0.93 (0.55–1.60)	1.23 (0.77–1.96)
Former	1,470	2,420	23.8 (21.4–26.2)	22.4 (19.0–25.8)	1.20 (0.85–1.71)	1.39 (1.00–1.94)
Never	2,905	6,137	60.3 (57.3–63.2)	61.4 (57.2–65.5)	0.94 (0.79–1.13)	0.81 (0.65–1.00)
Age of asthma onset, yr						
<18	1,801	4,678	48.4 (45.3–51.4)	42.8 (33.1–52.5)	0.85 (0.67–1.09)	0.95 (0.80–1.15)
18	3,079	4,991	51.6 (48.6–54.7)	57.2 (47.5–66.9)	1.15 (0.95–1.40)	1.05 (0.88–1.24)

Characteristics	Total		Health Care Workers/ Volunteers (N = 570) % <sup>‡</sup> (95% CI)	Non-Health Care Workers/ Volunteers (N = 2437) % <sup>‡</sup> (95% CI)	Unadjusted PR (95% CI)	Adjusted PR <sup>§</sup> (95% CI)
	N*	Weighted N (in Thousands) <sup>†</sup>				
Asthma control level <sup>//</sup>						
Well controlled	2,934	6,188	56.3 (46.3–66.4)	63.1 (59.2–67.0)	0.89 (0.74–1.08)	0.91 (0.75–1.11)
Not well controlled	1,292	2,355	27.5 (17.9–37.1)	21.8 (18.6–25.0)	1.26 (0.86–1.86)	1.25 (0.85–1.83)
Very poorly controlled	900	1,653	16.1 (8.3–24.0)	15.1 (12.3–17.9)	1.07 (0.63–1.82)	0.99 (0.60–1.65)
Asthma attack <sup>¶</sup>						
Yes	2,505	5,085	64.9 (56.2–73.6)	49.0 (44.7–53.3)	1.32 (1.12–1.56)	1.23 (1.03–1.46)
No	2,590	5,064	35.1 (26.4–43.8)	51.0 (46.7–55.3)	0.69 (0.53–0.90)	0.77 (0.59–1.00)
Routine checkup for asthma <sup>¶</sup>						
Yes	3,026	6,312	62.0 (52.1–71.9)	63.8 (59.9–67.7)	0.97 (0.82–1.16)	1.07 (0.92–1.25)
No	2,069	3,849	38.0 (28.1–47.9)	36.2 (32.3–40.1)	1.05 (0.79–1.39)	0.89 (0.66–1.20)
Urgent treatment for worsening asthma <sup>¶</sup>						
Yes	1,087	2,062	25.6 (17.4–33.8)	19.6 (16.3–22.9)	1.31 (0.90–1.88)	1.08 (0.75–1.57)
No	4,026	8,108	74.4 (66.2–82.6)	80.4 (77.1–83.7)	0.93 (0.82–1.04)	0.98 (0.88–1.09)
Asthma-related emergency room visit <sup>¶</sup>						
Yes	508	1,146	18.6 (10.7–26.6)	10.2 (7.8–12.6)	1.83 (1.10–3.07)	1.53 (0.88–2.65)
No	4,612	9,038	81.4 (73.4–89.3)	89.8 (87.4–92.3)	0.91 (0.82–1.01)	0.93 (0.84–1.04)
Asthma-related hospitalization <sup>¶</sup>						
Yes	80	89	NR (NR)	0.8 (0.4–1.1)	NR (NR)	NR (NR)
No	5,045	10,096	99.5 (99.0–99.9)	99.2 (98.9–99.6)	NR (NR)	NR (NR)
Activity limitation because of asthma <sup>¶</sup>						
At least 1 d	1,312	2,712	34.5 (25.3–43.7)	27.1 (23.3–30.9)	1.27 (0.94–1.73)	1.19 (0.87–1.62)
No days	3,749	7,340	65.5 (56.3–74.7)	72.9 (69.1–76.7)	0.90 (0.77–1.05)	0.93 (0.80–1.08)
Time since last talked to the health professional about asthma						
Within past year	3,489	6,599	69.4 (60.7–78.2)	62.5 (58.1–66.8)	1.11 (0.96–1.28)	0.99 (0.84–1.15)
1 yr ago or more	1,620	3,572	30.6 (21.8–39.3)	37.5 (33.2–41.9)	0.82 (0.60–1.11)	1.03 (0.78–1.35)
Time since last took asthma medication						
Within past year	4,179	8,034	85.4 (78.8–92.0)	77.8 (73.8–81.9)	1.10 (1.00–1.20)	1.04 (0.94–1.16)
1 yr ago or more	933	2,142	14.6 (8.0–21.2)	22.2 (18.1–26.2)	0.66 (0.41–1.07)	0.84 (0.52–1.35)

Characteristics	N*	Total		Health Care Workers/ Volunteers (N = 570) %‡ (95% CI)	Non-Health Care Workers/ Volunteers (N = 2437) %‡ (95% CI)	Unadjusted PR (95% CI)	Adjusted PR§ (95% CI)
		Weighted N (in Thousands)†	%‡ (95% CI)				
Time since last had asthma symptoms							
Within past year	4,425	8,710	86.2 (84.0–88.3)	90.6 (85.6–95.5)	85.4 (82.3–88.5)	1.06 (0.99–1.13)	1.07 (1.00–1.14)
1 yr ago or more	639	1,400	13.8 (11.7–16.0)	9.4 (4.5–14.4)	14.6 (11.5–17.7)	0.65 (0.37–1.14)	NR (NR)
Advised to change things in environment							
Yes	2,141	4,564	45.1 (42.1–48.2)	60.2 (51.5–68.8)	43.8 (39.6–48.1)	1.37 (1.15–1.64)	1.26 (1.04–1.52)
No	2,962	5,547	54.9 (51.8–57.9)	39.8 (31.2–48.5)	56.2 (51.9–60.4)	0.71 (0.56–0.90)	0.79 (0.63–0.99)
Work-related asthma status							
Work-related asthma	440	813	8.0 (6.4–9.6)	7.5 (2.2–12.9)	7.9 (5.7–10.2)	NR (NR)	NR (NR)
Possible work-related asthma	2,001	3,797	37.5 (34.7–40.3)	40.2 (30.6–49.8)	38.3 (34.3–42.4)	1.05 (0.80–1.36)	1.06 (0.81–1.37)
Non-work-related asthma	2,668	5,513	54.5 (51.5–57.4)	52.3 (42.4–62.2)	53.7 (49.5–58.0)	0.97 (0.79–1.20)	0.98 (0.80–1.20)
Change or quit job because of asthma							
Yes	329	661	6.5 (4.9–8.1)	NR (NR)	7.1 (4.9–9.3)	1.39 (0.61–3.17)	NR (NR)
No	4,771	9,506	93.5 (91.9–95.1)	90.2 (82.7–97.7)	92.9 (90.7–95.1)	0.97 (0.89–1.06)	0.96 (0.87–1.05)
Total	5,128	10,196			19.1 (15.8–22.4)	3.9 (2.4–5.4)	

\* Unweighted sample size. The numbers for characteristic subgroups may not add to total because of missing values. The sample size for health care workers/volunteers and non-health care workers/volunteers does not sum to total because only a subset of respondents completed both the High Risk/Health Care Worker Module and Asthma Call-Back Survey.

<sup>†</sup> Weighted to the state population using the survey sample weights for each Asthma Call-Back Survey participant.

<sup>‡</sup> Results presented as weighted average annual estimate.

<sup>§</sup> Prevalence ratio, adjusted for age, sex, annual household income, and health insurance status.

// On the basis of the National Asthma Education and Prevention Program "Expert Panel Report 3 (EPR-3): Guidelines for the Diagnosis and Management of Asthma" criteria using responses to questions on asthma symptoms, nighttime awakenings, and rescue medication use.<sup>1</sup>

<sup>¶</sup> In the past 12 months.

CI, confidence interval; NR, not reportable, relative standard error 30%; PR, prevalence ratio.